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ORIGINAL PAPER

A decision making model for investment and development of construction panels

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Abstract: A study was conducted to select the best alternative for the development of construction panels as well as investment in its manufacturing in Iran. Three alternatives are considered, cement–bonded wood composite product, substituted products (such as concrete panel) sandwich panel and a mixture of them. We apply the analytic network process (ANP) to achieve this goal. A hierarchy is designed to prioritize benefits, opportunities, costs and risks (BOCR) by using the Analytic Hierarchy Process (AHP) ratings approach. To evaluate the "control criteria" of the system, a control hierarchy is also created and prioritized by applying the Analytic Network Process (ANP). A total of four major control criteria in the system are prioritized where each one controls a decision network evaluated using ANP. The final synthesis of the system shows cement–bonded wood composite product is the best choice among three potential alternatives for the investment and development.

Keywords: cement-bonded wood composite; foamed concrete; Analytic Network Process

Introduction

There is a serious deficit in lingo-cellulose resources in Iran to produce various forest products, such as construction boards. The usage of wastes for producing cement-bonded composite seems to be a proper solution to manufacture construction panels which result in cheaper construction materials as well as decreasing the weight of buildings.

In recent years cement-bonded wood composite (CBWC) products have received renewed attention as environmentally friendly materials. Theses products require low quality wood and are resistant to fire, decay and insect attack. On the other hand, they involve no toxic chemicals, and can be broken down to relatively landfill at the end of service life. In tropical countries CBWC holds promise for adding value to the tropical timber resource as a source of building materials rather than a nuisance that must be cut and burned to clear land for agriculture. CBWC products have been used in the U.S. for more than 60 years. As a general class of material, a wide range of forms and functions are available. High density product (1.5 to 2 $g \cdot mL^{-1}$), containing wood fiber amounting from 5% to 10% of the weight of the cement, are often used in the applications that require a durable wear-resistant surface, such as roof shingles or siding (Wolfe and Gjinolli 1996). Lower density materials (0.5 to 1 $g \cdot mL^{-1}$) have traditionally been used where sound absorption and fire resistance are important (Geimer et al. 1996). Little attention has been given in the literature to the performance of these materials in engineered application.

CBWC products also have the substituted products. One of the most important one is "foamed concrete". It is some kind of new cover used in buildings. Due to its physical specifications, it creates insulation, and it is light and resistant. Auriferous light foam has two levels of densities (http://civil- omran.blogfa.com/post-23.aspx): 400–900 $kg \cdot m^{-3}$ is for lighter construction block, ornamental block and panels; 1 000–1 800 $kg \cdot m^{-3}$ is for heavier and armed block.

The use of foamed concretes in buildings results in better heating and cooling costs. Furthermore, the use of foamed concrete in construction projects decreases the labor costs due to the shorter period of erection as well as the lighter weights of the walls.

In this research, we develop a method to obtain the best alternative among the existing ones for investment and development of different construction panels. These alternatives are cement-bonded wood composite product, its substitute products (such as foamed concrete) and a mixture of them. To model this problem, the analytic network process (ANP) developed by Saaty (2001a) is an appropriate tool. The classical analytical

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methods do not work well because many aspects of this project, especially the social parts of it, can not be quantified properly. Furthermore, these methods are usually developed on the basis of some simplifying assumptions or they cannot be solved analytically otherwise. That is why some real world problems are far from the models constructed on the basis of these restrictive assumptions. On the other hand, the qualitative methods are not rigorous enough in favor of this case. We can mention some ANP applications as follows: in regional planning (Banai 2005), analyze network economy (Fiala 2005), potential highway alignments (Piantanakulchai 2005), national missile defense system (Saaty 2001d), policy relationship (Alikafa and Ozdemir 2003), regional financial arrangement (Azis 2003), engineering discipline (Poonikom et al. 2003), food marketing (Ilker et al. 2004), ERP system (Cevik et al. 2004), trade relations (Saaty and Cho 2001b), supplier selection (Gencer and Gurpinar 2007), R&D project selection (Habib et al. 2007), facility location (Partovi 2006), energy policy (Ulutas 2005), product mix planning (Chang et al. 2005), and industrial location (Azizi and Modarres 2007).

The analytic network process (ANP)

The Analytical Network Process (ANP), a generalization of the Analytic Hierarchy Process (AHP) method for multi criteria decision making, provides a broader framework in complicated environments. It allows interactions and feedback within clusters (inner dependence) and between clusters (outer dependence). The ANP is a coupling of two parts. The first part consists of a control hierarchy or network of criteria and sub-criteria that control the interactions in the system under study. The second part is a network of influences among the elements and clusters. The network varies from criterion to criterion and a super-matrix of limiting influence is computed for each control criterion. Finally, each of these super-matrices is weighted by the priority of its control criterion. The results are synthesized through addition for all the control criteria. In the current research, ANP model is described through the following elements.

ANP model

The Alternatives

There are three potential alternatives for investment and development of construction panels: Wood-cement products, substituted products (for example foamed concrete), and combination of wood-cement and substituted products.

Overall factors

In this research the merits of benefits, costs, opportunities and risks are weighted by five general factors, liable to one of the following broad categories. (1) Environmental factors: related to the production process issues; (2) Cultural & social factors (divided into three factors): Literacy and culture level; Population growth; and Occupation; (3) Economic factors; (4) External commerce factors: related to the products imports regulations, which is used in construction activities; (5) Governmental regulations factors: related to production regulations in the country.

Ratings of general factors are done by pair-wise comparison of the lower level factors and summing up for the main factors at the top level.

Prioritizing BOCR

Since BOCR are not equally important, it is necessary to prioritize them. Five possible ratings ranging from "very high" to "very low" are used. The results of the influence of overall factors on the merits of benefits, costs, opportunities, risks, and the priority of the above mentioned merits are reported in Table 1.

Table 1. Priority rating for the merits: Benefits, Costs, Opportunities and Risks.

		Benefits	Costs	Opportunities	Risks
Economic (0.501)		Very high	Very high	Very high	Very High
Governmental regulations(0.143)		Low	High	Very High	Medium
External commerce(0.057)		Very low	High	High	Medium
Environmental (0.08)		Very high	Medium	Very high	Low
Cultural and social (0.218)	Population growth (0.582)	Low	Low	Very high	High
	Occupation (0.109)	Low	Low	Very high	Low
	Literacy level (0.309)	Medium	Low	Very high	Very high
Overall priorities		0.204	0.22	0.309	0.267

Very high (1), high (0.51), medium (0.252), low (0.124), and very low (0.065).

Benefits to the investors and manufacturers

Technical and technological criteria

(1) Thermal and heat isolation: Due to the existence of cellulose fiber in wood-cement, transmissibility of thermal is low. Therefore, the product has thermal insulation property which results in consumption of energy (www.eltomation.nl/page 5).

Also using of foamed concrete eventuates saving in using of heater equipment.

(2) Humidity insulation: because of the existence of cement inside of the product, it is possible to use it in humid locations and external parts of the building. Due to the physical specification of foamed concrete creates insulation, light, resistant and favorable quality foam. It functions as a proper insulation against humidity.

(3) Sound insulation: there are many sound absorbent materials in the wood-cement combinations which decreases medium frequency sounds (www.favorsea.com).

Foamed concrete with density 300−500 kg·m^{-3} functions as a

proper insulation against heat and sound.

(4) Higher mechanical resistance: wood-cement products and armed block of foamed concrete have higher mechanical resistance in comparison with other panel products (http://toolbase.org/technology_inventory).

(5) Better application: transportation capabilities in construction activities has promoted a new generation of pre-fabricated residential buildings.

Furthermore, chemical and mechanical specification of the wood-cement is incomparable. Foam concrete has favorable combination of weight, volume and packaging. Therefore, it is convenient as far as transportation is considered.

Economic criteria

Economic criteria are divided in two sub-criteria:

(1) Saving construction costs. Due to the utilization of the wastes, construction material is cheaper. Furthermore, due to the insulation property of wood-cement products, the cost of insulation will be omitted. Production of foamed concrete need low capital investment and has high flexibility with respect to consumers' budget. Foamed concrete weighs from 10% to 87% less than standard heavy concrete. Sufficient reduction of weight leads to sufficient economy on basements (http://www.ibeton.ru/english/intro.php).

(2) The use of the wastes. It is important when the resource is deficit. The application of wastes in the product leads to consumption optimization (Kaushal 1995).

Safety criteria,

There are two subsections about safety criteria:

(1) Safety against earthquake: the product (wood-cement) is very resistant to earthquake force by absorbing the forces and resisting destruction. Foamed concrete products have manufactured based on innovative construction system and new materials and industrial production. High value for air conditioning and energy technology, accordingly, provide security against earthquakes, hurricanes and tsunamis (http://www.cpwrconstructionsolutions.org).

(2) Safety against fire: the product (wood-cement) is not flammable. It is durable against fire for a period of 6 hours. Toxic agent is not also generated. Foamed concrete is extremely fire resistant and well suited to applications where fire is a risk. Tests show that in addition to prolonged fire protection, the application of intense heat, such as a high energy flame held close to the surface, does not cause the concrete to spall or explode, which happens in the normal dense weight concrete.

Environmental criteria

With respect to incomparable and various specifications of the product (wood-cement), it is possible to apply it in all types of weather conditions.

Long lasting foamed concrete, applied as a surface cover on landfill sites and effluent ponds and lagoons, will effectively suppress noxious odors, vapors, litter and vectors, and avoid serious environmental issues (http://www.alliedfoamtech.com/index.html).

Opportunities to the investors and manufacturers

Engagement creation

Establishment of the new factories creates new employment opportunities. Technology of foamed concrete production is simple and requires minimum skilled workforce and primarily deploying unskilled labor.

Less destruction of the environment

Due to the usage of wastes and wood-cement as construction materials, the resources are destructed less. When it is maintained, foamed concrete does not produce toxic substances and has ecological compatibility. The product is also environment friendly, neither wasting natural resources nor creating pollution.

Export possibilities

Economic development and better production leads to the export of the product to the neighboring countries.

Investment return

Due to the optimal usage of wastes as well as the lower construction costs in wood-cement, the investment return will be possible in short time. Start up of foamed concrete production does not need heavy capital investment. Therefore, the investment return period is not long.

Rural modernization

With respect to the speed of construction by wood-cement, it is appropriate for modernization of villages. Furthermore, foam concrete technology is simple and easy to execute in less developed areas such as villages.

Costs to the investors and manufacturers

Purchase of raw material: procurement of raw material in wood-cement (which includes cement, concrete and lignocelluloses material) has the highest share in the finished cost to produce of the product. Raw materials of foamed concrete products are sand, cement; water and foam, as raw material costs.

Wastes transportation costs: the cost includes lignocelluloses wastes transportation from the location of the wastes to the factory.

Application limits of the species: with respect to the existence of simple sugar in wood which eventuates in the non absorption of cement, we have to use lignocelluloses resources because of the less amount of sugar in wood-cement. There is not similar limit about other construction panels.

Risks to the investors and manufacturers

Less acknowledgement and welcome: because the products (wood-cement) are not familiar for customers, it may not be welcomed generally. The production system of foamed concrete is an innovative construction system based on new materials and industrial production.

Undesirable product: the lack of experience can result in low quality product.

Low selling amount and high storage cost: because the products are not familiar to the public, the low level of sale may increase the storage cost of products.

Low competition abilities: with respect to similar specification and lower costs of substituted products to replace together, may decrease the competition ability of the products.

Prioritizing overall factors: From the results of Table 1, economic criterion (0.501) is the most important overall factor on BOCR. The governmental regulations (0.143); environmental (0.08); cultural & social factors (0.218) and external commerce (0.057) are other factors, respectively. With respect to the influence of the overall factors on BOCR, benefits, costs, risks and opportunities have the weighing values of 0.204, 0.22, 0.267and 0.309, respectively.

Prioritizing criteria and alternatives

Establishment of statistical method, determination and calculation of rating coefficients: After the hierarchy is drawn up for criteria and sub-criteria which influence the selection of the appropriate alternative, the questionnaire is prepared to gather the opinions of the experts. The criteria and sub-criteria are evaluated based on pairwise comparisons. Then, the priority rate of each criteria and sub-criteria are compared. First, geometric mean is calculated for each one of the matrix cells by the following formula (Saaty 2000):

$$Gj\ a_{12} = (a_{12}1 * a_{12}2 * \ldots . * a_{12}N)^{1/N} \quad (1)$$

Where, Gj is Group Judgement, and a is amount of each of matrix cells.

After the geometric means of all matrix cells are calculated, the results are normalized. The criterion and sub-criterion weighting value are obtained through the integration of the weight of the low-level elements into the weight of the related up-level elements.

The results of geometric mean matrices and weighted super matrix for benefits criteria and sub criteria which are extracted from Super Decisions software (Appendix 1: Fig. 1–14 and Appendix 2), are as follows. For example, with respect to "economic criteria", "reduce of construction cost" is more important than "use of residues" (Appendix 1: Fig. 2). With respect to "reduce of construction cost" three alternatives have been compared together (Appendix 1: Fig. 13). Similarly, the results for costs, opportunities and risks can be developed. After pairwise comparisons between sub-criteria for benefits, costs, opportunities and risks by ANP as well as pairwise comparisons of the criteria and choices against each other. By the above-mentioned merits, the results are reported in Table 2.

As shown in Table 2, higher mechanical resistance (0.182), Engagement creation (0.339), Purchase of raw material (0.432) and less acknowledgement and welcome (0.328) have the highest priority in terms of benefits, opportunities, costs and risks criteria, respectively. Regarding alternatives, wood-cement product has the highest priority with respect to benefits (0.41) and opportunities (0.43). Also substitution products have highest priority with respect to costs (0.399) and risks (0.369).

In BOCR structure the following formula is used in calculations (Saaty 2001c):

$$\text{Additive amount} = \frac{\text{Benefits} \times \text{Opportunit ies}}{\text{Costs} \times \text{Risks}} \quad (2)$$

Final outcome

By integration of the weights of the merits of benefits, costs, opportunities and risks, and the weights of choices against the above mentioned merits, the final scores are reported in Table 3.

As shown in Table 3, wood-cement product has the highest priority, and is the most suitable choice for investment and development of panel products in Iran. Considering the merits in decision-making, wood-cement product has the highest priority. The second and third are mixes of wood-cement and substitution products, respectively.

Analysis

BOCR analysis

With respect to Table 1, "Benefits" has the forth priority in decision-making compared to costs, opportunities and risks. It has the weight (0.204). From Table 2, it is implied that "Technical and technological" criteria (0.596) has the highest priority in terms of benefits. With respect to technical and technological criteria, "higher mechanical resistance" sub criteria have the highest weight (0.182) in comparison with other criteria of benefits. Accordingly mechanical resistance criteria have to uphold via more investigations on tests and studies of the product resistance until the quantities of the resistance approximate to relative standards. As shown in Table 1, "Opportunities" is the most important factor in decision-making compared to benefits, cost and risks, because it has highest weight (0.309). From Table 2, engagement creation (0.339) is the most important criteria in terms of opportunities. Whereas, the development and investment of wood cement product in the country leads to the creation of engagement and increases the new opportunities related to employment. "Costs" is the third merit as shown in Table 1, because it has weighing value of 0.22. With respect to Table 2, purchase of raw material (0.432) has the highest priority in terms of costs, because of the lack of the proper raw material to produce final product. Furthermore, owing to the use of it by various wood industries demand increases and consequently, supply decreases. The producers have to use low price and high quality of raw material until the cost of final product is decreased to compete with other similar products. "Risks" is the second merit, because it has weight (0.267) with respect to Table 1. As shown in Table 2, less acknowledgement and welcome (0.328) is involved with an important risk. Since the product is unknown and is less wel-

comed by the customers, it is necessary to promote the product by advertising.

Table 2. Synthesized Priorities of the 22 Criteria, Sub criteria and alternatives (Parenthesis results for weighing values of the criteria are global priorities).

Merits	Criteria	Sub criteria	Wood-cement product	Substitution products	Mix of wood-cement & substitution products
Benefits (0.204)	Technical and techno-	thermal and heat isolation (0.107)	0.281	0.281	0.438
	logical (0.596)	humidity insulation (0.098)	0.459	0.23	0.31
		sound insulation (0.057)	0.34	0.24	0.42
		higher mechanical resistance (0.182)	0.386	0.2	0.414
		better application (0.152)	0.366	0.227	0.407
	Economic (0.197)	decreased to construction costs (0.157)	0.459	0.184	0.357
		use of the wastes (0.04)	0.339	0.235	0.425
	Safety (0.121)	safety against earthquake (0.09)	0.546	0.15	0.304
		safety against fire (0.031)	0.487	0.179	0.334
	Environmental (0.087)		0.469	0.223	0.307
Benefits Synthesized			0.197	0.111	0.181
Benefits Normalized			0.4104	0.2139	0.3757
Opportunities (0.309)	Engagement creation (0.339)		0.446	0.209	0.345
	Less destruction of the environment (0.219)		0.434	0.201	0.365
	Export possibilities (0.113)		0.452	0.204	0.343
	Investment return (0.16)		0.392	0.252	0.356
	Villages modernization (0.17)		0.434	0.201	0.365
Opportunities Synthesized			0.4336	0.212	0.3544
Opportunities Normalized			0.4336	0.212	0.3544
Costs (0.22)	Purchase of raw material (0.432)		0.345	0.244	0.41
	Wastes transportation (0.204)		0.352	0.238	0.41
	Application limits of the species (0.363)		0.291	0.321	0.387
Costs Synthesized			0.3267	0.2712	0.402
Costs Normalized			0.3267	0.2712	0.402
Costs Reciprocal			0.331	0.399	0.268
Risks (0.267)	Less acknowledgement and welcome (0.328)		0.332	0.327	0.341
	Undesirable product (0.27)		0.37	0.29	0.34
	Decrease of selling amount and increase of storage cost (0.142)		0.338	0.282	0.379
	Low competition abilities (0.261)		0.317	0.281	0.401
Risks Synthesized			0.3393	0.2988	0.362
Risks Normalized			0.3393	0.2988	0.362
Risk Reciprocal			0.326	0.369	0.305

Table 3. Final Outcome for Priorities of the Alternatives

Mer. / Alter.	Benefits (0.204)	Opportunities (0.309)	Costs (0.22)	Risks (0.267)	Final out-come additive	Ranking
wood-cement product	0.4104	0.4336	0.331	0.326	0.3748	1
substitution products	0.2139	0.2120	0.399	0.369	0.2998	3
mix of wood-cement & substitution products	0.3757	0.3544	0.268	0.305	0.3254	2

Alternative analysis

As shown in Table 3, development and investment of wood-cement product with the highest priority (0.3748) is the most suitable choice for the investors and manufacturers. Regarding the benefits and opportunities, the results are shown in table 2. Wood-cement product has the highest priority (0.4104, 0.4336). With respect to the influence of the overall factors on the merits of benefits, costs, opportunities and risks (Table 1), opportunities is the most important factor in decision-making. Therefore, to increase the "opportunities" value in the future, the investors and manufacturers have to uphold and support wood-cement development. Of course, both of the first and second final priorities (Table 3) are recommend developing and investing in wood-cement.

With regard to above mentioned priorities of wood-cement product in comparison with other construction panels, we can

conclude that wood-cement product has higher priorities with respect to resistance to fire and heat changes. This product resists against fire up to 4–6 hours. The property of not absorbing water as well as its resistance to climate changes in construction industries is a significant advantage. Iran is considered as high risk as far because the earthquake is concerned. The buildings which are constructed with wood-cement panels are very resistant to shear load due to the earthquake and absorbing the force. Thus, the buildings resist to destruction. This property is especially very important for rural building in villages to reduce financial and physical damages, when the earthquake happens. The other properties of this product are resistance to fungus and insects, sound isolation, heat isolations, moisture absorption and adjustment of humidity of the environment, machining, optimum utilization of the wastes. The results of the current research are also confirmed by Wolfe and Gjinolli (1996). They concluded that cement-bonded wood composite has the potential to serve in a variety of structural applications. In addition to a proven history of sound absorption and an inherent resistance to fire, termites, and decay, these panels can be produced to meet the strength and freeze-thaw requirements for highway sound barriers. This product also seems to be suitable for housing applications in tropical and semitropical environments.

Sensitivity Analysis

Since there may be different judgments about the comparison of priority rates of benefits, opportunities, costs, and risks or their sub-criteria, to achieve stability and compatibility of the analysis, we apply sensitivity analysis (Saaty 2001d).

It can be shown that by increasing or decreasing the weight of one criterion, the ratios of the weights of other three criteria (with respect to each other) remain unchanged, although the sum of their weights changes accordingly. For example, if the weight of benefit increases from 0.204 to 0.5, then the new weights of costs, opportunities and risks will be 0.138, 0.194 and 0.168, respectively. Although the sum of these weights decreases to 0.5, they are proportional to the previous ones, i.e. 0.22, 0.309 and 0.267 (Table 1).

Table 4. The results of sensitivity analysis.

New Priorities	New Weight	Basic Weight	Criterion
W, S, M	0.05	0.204	Benefits
W, S, M	0.132	0.309	Opportunities
W, S, M	0.354	0.22	Costs
S, W, M	0.636	0.22	Costs
W, S, M	0.464	0.267	Risks
S, W, M	0.721	0.267	Risks

To perform sensitivity analysis, we apply the software developed by Saaty (2001b). The results are illustrated in Fig. 1a–1d. Some cases of weights changes are presented in Table 4. As can be seen in Table 3, the priorities are W (wood-cement product), S (substituted products) and M (the mixture of wood-cement and substituted products). After changing the weights of one criterion, the priorities also change, as shown in Table 4. With respect to this table, costs and risks are more sensitive than benefits and opportunities.

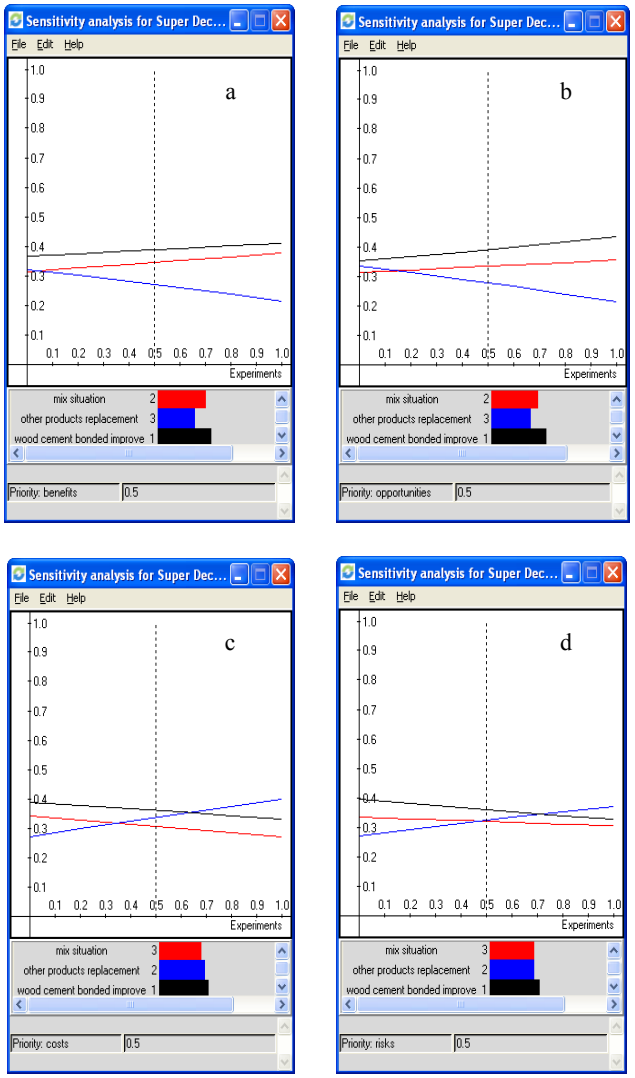

Fig. 1 Sensitivity analysis for (a) benefits, (b) opportunities, (c) costs and (d) risks.

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Appendix 1: Figures 1-14:

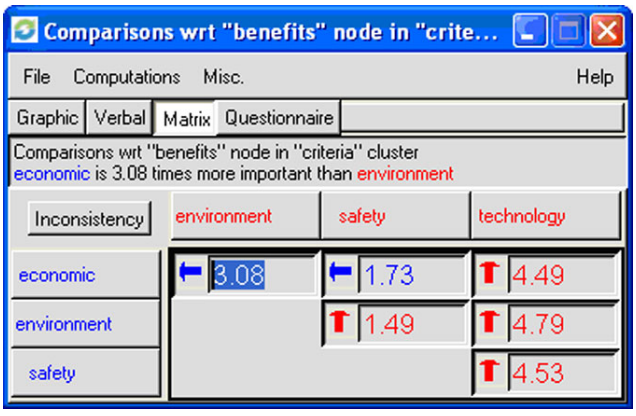

Fig. 1 Criteria comparison matrix with respect to benefits

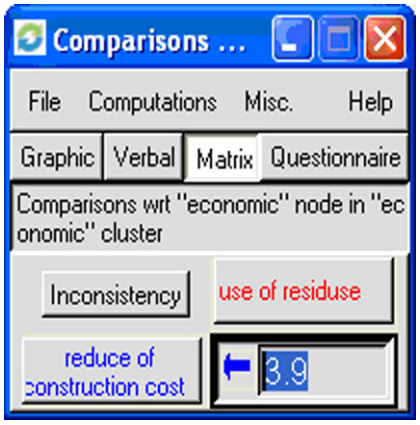

Fig. 2 Sub-criteria comparison matrix with respect to economic

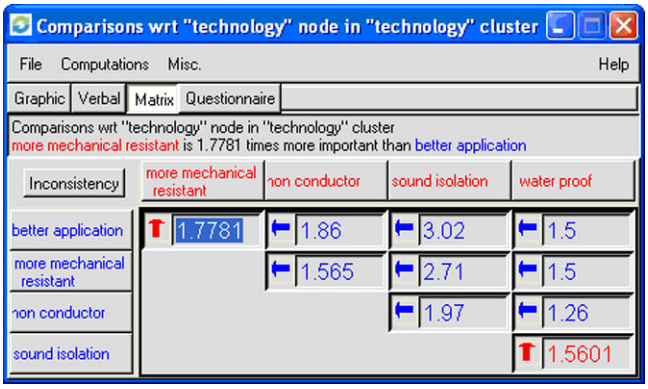

Fig. 3 Sub-criteria comparison matrix with respect to technology

Fig. 4 Sub-criteria comparison matrix with respect to safety

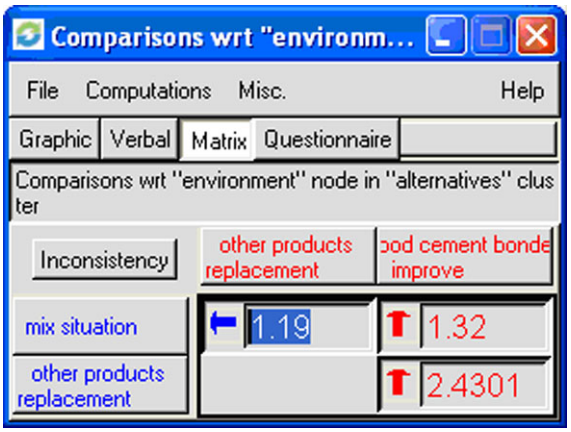

Fig 5 Alternatives comparison matrix with respect to environment

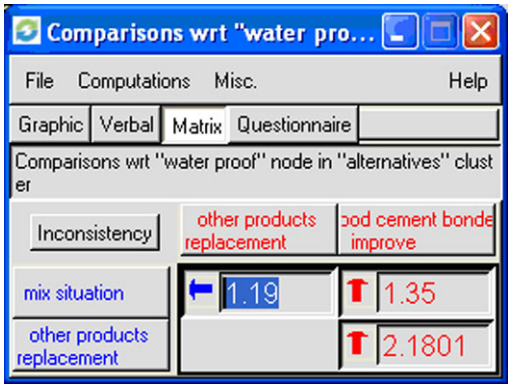

Fig. 6 Alternatives comparison matrix with respect to humidity insulation

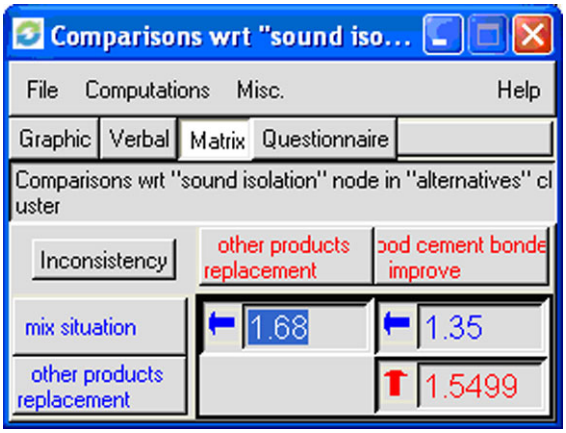

Fig. 7 Alternatives comparison matrix with respect to sound isolation

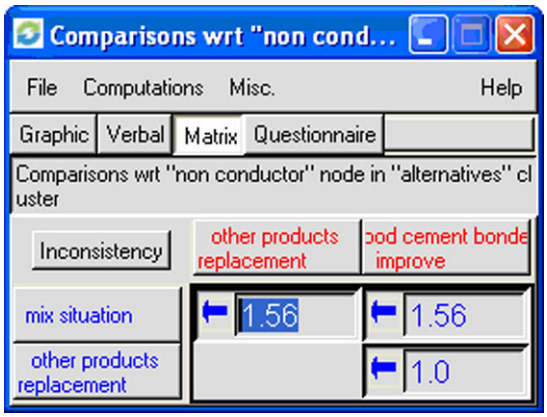

Fig. 8 Alternatives comparison matrix with respect to thermal and heat isolation

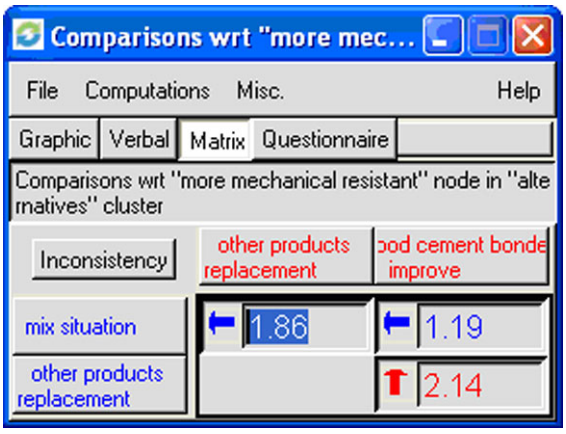

Fig 9 Alternatives comparison matrix with respect to more mechanical resistance

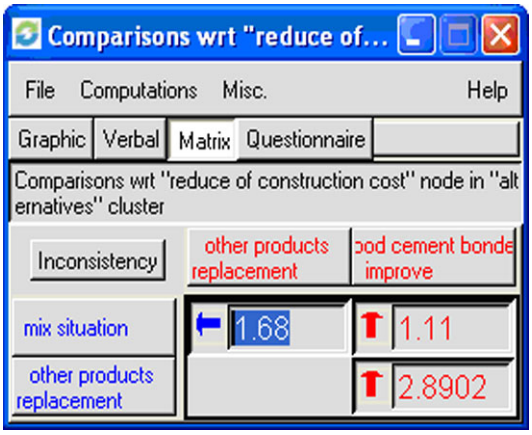

Fig. 12 Alternatives comparison matrix with respect to earthquake safety

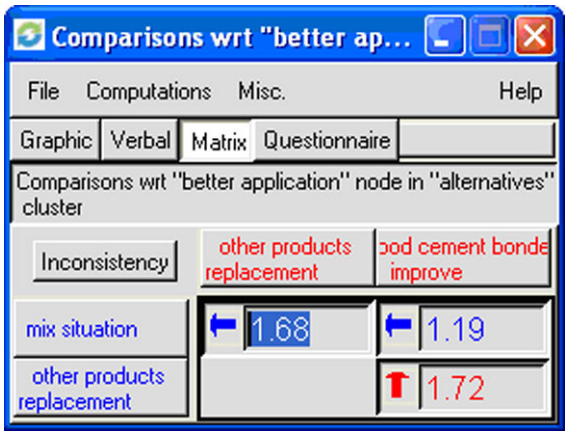

Fig. 10 Alternatives comparison matrix with respect to better application

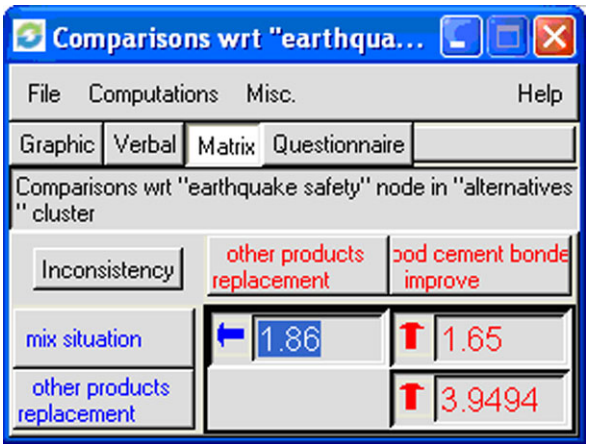

Fig. 13 Alternatives comparison matrix with respect to reduce of construction costs

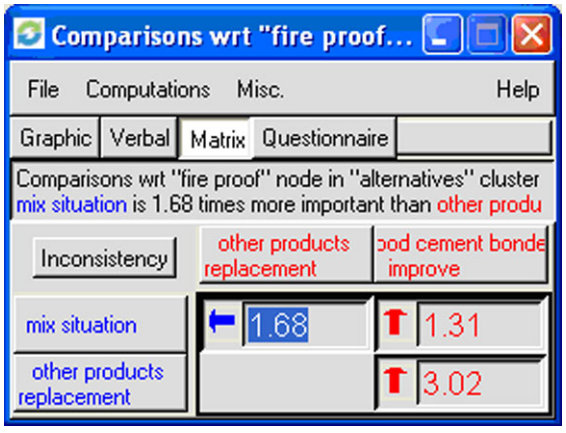

Fig. 11 Alternatives comparison matrix with respect to safety against fire

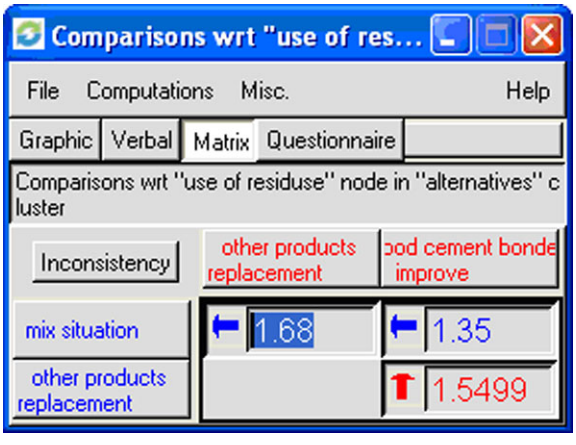

Fig. 14 Alternatives comparison matrix with respect to use of the wastes

Appendix 2: Results of weighted super matrix for benefits

Cluster Node Labels		Alternative			Benefits		Criteria		
		Mix situation	Other products replacement	Wood cement bonded improve	Benefits	Economic	Environment	Safety	Technology
Alternative	Mix situation	0.000000	0.000000	0.000000	0.000000	0.000000	0.307385	0.000000	0.000000
	Other products replacement	0.000000	0.000000	0.000000	0.000000	0.000000	0.223341	0.000000	0.000000
	Wood cement bonded improve	0.000000	0.000000	0.000000	0.000000	0.000000	0.469273	0.000000	0.000000
Benefits	Benefits	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Criteria	Economic	0.000000	0.000000	0.000000	0.196590	0.000000	0.000000	0.000000	0.000000
	Environment	0.000000	0.000000	0.000000	0.086882	0.000000	0.000000	0.000000	0.000000
	Safety	0.000000	0.000000	0.000000	0.120852	0.000000	0.000000	0.000000	0.000000
	Technology	0.000000	0.000000	0.000000	0.595675	0.000000	0.000000	0.000000	0.000000

Cluster Node Labels		Economic		Safety			Technology			
		Reduce of construction cost	Use of residues	Earthquake safety	Fire proof	Better application	More mechanical resistant	Non conductor	Sound isolation	Water proof
Alternative	Mix situation	0.357281	0.425494	0.304044	0.334294	0.407360	0.413686	0.438202	0.425494	0.307347
	Other products replacement	0.183768	0.235401	0.150284	0.179065	0.227028	0.200297	0.280899	0.235401	0.233284
	Wood cement bonded improve	0.458951	0.339106	0.545672	0.486641	0.365612	0.386017	0.280899	0.339106	0.459369
Benefits	Benefits	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Criteria	Economic	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Environment	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Safety	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	Technology	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Cluster Node Labels		Alternative			Benefits		Criteria		
		Mix situation	Other products replacement	Wood cement bonded improve	Benefits	Economic	Environment	Safety	Technology
Economic	Mix situation	0.000000	0.000000	0.000000	0.000000	0.795918	0.000000	0.000000	0.000000
	Other products replacement	0.000000	0.000000	0.000000	0.000000	0.204082	0.000000	0.000000	0.000000
	Wood cement bonded improve	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.746193	0.000000
Safety	Benefits	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.253807	0.000000
Technology	Economic	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.255778
	Environment	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.305025
	Safety	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.178988
	Technology	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.096523
	Water proof	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.163686